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AN EMPIRICAL ANALYSIS OF PAY AND NAVY ENLISTED RETENTION IN THE AVF: PRELIMINARY RESULTS

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letter in jacket.

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INTRODUCTION

During the past year, CNA developed a career force retention model for OSD and used that model to analyze a variety of compensation issues. The model was developed primarily to analyze the retention effects of a change in the military retirement system (reference 1), but it has been used recently to estimate the effects of continued caps on military pay and termination of GI Bill benefits in 1989.

During the course of development of this model, it became clear that some of the model's parameters were based on little empirical evidence. For instance, pay elasticities at various career decision points were derived from an analysis of the relationship between FY 1977 reenlistment rates and estimates of the cost of leaving the military at those points. This analysis provided estimates of pay elasticities at career decision points other than the first-term point. However, since the analysis was based on so little data, it is not clear how reliable these elasticities are.

A second element of uncertainty pervaded the model. There is no existing evidence about the relationship between pay at one career decision point and retention at <u>future</u> decision points. If higher pay at one decision point serves to retain more people with negative tastes for service, retention at future decision points should fall when the cohort receiving the higher pay reaches these future decision points. The relationship between pay at one decision point and retention at _future_ points is important, for instance, in considering the effects of the OSD retirement plan. The cash payments at the 10th year of service may serve to retain more people up to YOS 10 than the current system. However, the dropoff in retention after YOS 10 may depend crucially upon the relationship just described. Reference 1 provides retention estimates for the OSD retirement plan under different assumptions about the relationship, but empirical evidence about the relationship is needed in order to determine just which estimates are most plausible. It was therefore recognized that an empirical analysis of the relationship between pay and retention at various career decision points was needed in order to update/refine the retention model's parameters.

At the same time, bonus program managers in OSD expressed a need for updated estimates of the effects of reenlistment bonuses. OSD therefore funded a follow-on study to derive better estimates of the retention model's parameters and in the process to estimate the effects of reenlistment bonuses.

The objectives of this effort are threefold. The first is to perform an empirical analysis of the relationship between pay and retention during the AVF era. In this analysis, we want to estimate the pay elasticities and bonus improvement factors at first-term and second-term reenlistment decision points. Pay elasticities and improvement factors have previously been estimated for the first-term reenlistment decision point, but not for the second-term point. To date, second-term bonus effects have only been inferred from the results of studies of first-term reenlistment bonuses.

One question to be answered is whether the effects of pay changes vary by occupation and branch of service. Because of their cross-section nature, previous studies have ben unable to determine whether pay effects vary by occupation. Using time series data during the AVF period, we will attempt to provide separate estimates by occupation as well as branch of service.

The second objective is to derive estimates of the relationship between pay at one decision point and retention at future decision points. No estimates of this relationship currently exist.

After performing this empirical analysis, we will update the retention model as necessary on the basis of the results of the empirical analysis. If necessary, we will update our estimates of the retention effects of the OSD retirement plan.

This memorandum presents the preliminary results of our analysis of Navy data during the FY 1974-78 period. It is organized as follows. The second section provides a brief discussion of the empirical methodology. A more lengthy discussion of the theoretical basis for the empirical model described below is contained in reference 2. The third section then presents the major results to date.

EMPIRICAL METHODOLOGY

Reference 2 presents a detailed discussion of various models of retention behavior, so we need not repeat that discussion here. However, all retention models involve (1) the calculation of some military-civilian pay difference variable and (2) an equation linking this pay difference variable to the reenlistment rate. Our empirical analysis applies a model called the annualized cost of leaving model. The annualized cost of leaving, A, is the individual's perceived difference between yearly military pay (M) over some future time horizon and yearly civilian pay (C) over the same time horizon. These annualized values depend upon the individual's discount rate. At a zero discount rate M and C are simply the average yearly values of the streams of military and civilian pay over the horizon, and A is simply the difference between these average values. Discounting at some positive rate simply serves to put more weight on dollars received earlier in the time horizon and less weight on dollars received later in the time horizon. The relative weighting of earlier and later dollars is of course directly related to the level of the discount rate. Throughout the empirical analysis, we have assumed a 10 percent discount rate.

In this model, each individual makes a stay-leave decision by comparing his distaste for service factor (which is the negative of his taste for service factor γ) with A. If $-\gamma$ is less than A he stays, and if $-\gamma$ exceeds A, he leaves. This just means he stays if his yearly distaste for service is less than the perceived yearly differential between military and civilian pay, and he leaves if his yearly distaste for service exceeds the perceived pay differential.[1]

The reenlistment rate r is the porportion of individuals for whom $-\gamma<A$, or for whom $\gamma>-A$. Mathematically, r may be derived as follows. Let $f(\gamma)$ be the distribution of γ among the individuals in the reenlistment pool. Then, the reenlistment rate is,

$$r = \Pr(\gamma>-A) = \int_{-A}^{\infty} f(\gamma)d\gamma \qquad (1)$$

If the taste distribution is symmetric, then $f(-\gamma) = f(\gamma)$. In this case, r can be rewritten as,

$$r = \Pr(A>-\gamma) \int_{-\infty}^{A} f(\gamma)d\gamma \qquad (2)$$

The assumption of a normal distribution of tastes gives rise to an S-shaped relationship between r and A. This relationship is illustrated in figure 1. The annualized cost of leaving is plotted on the horizontal axis,

[1]This discussion is somewhat skimpy, since the full model also includes a transitory disturbance term to the stay-leave decision. See reference 2. However, the above discussion conveys the essence of the model.

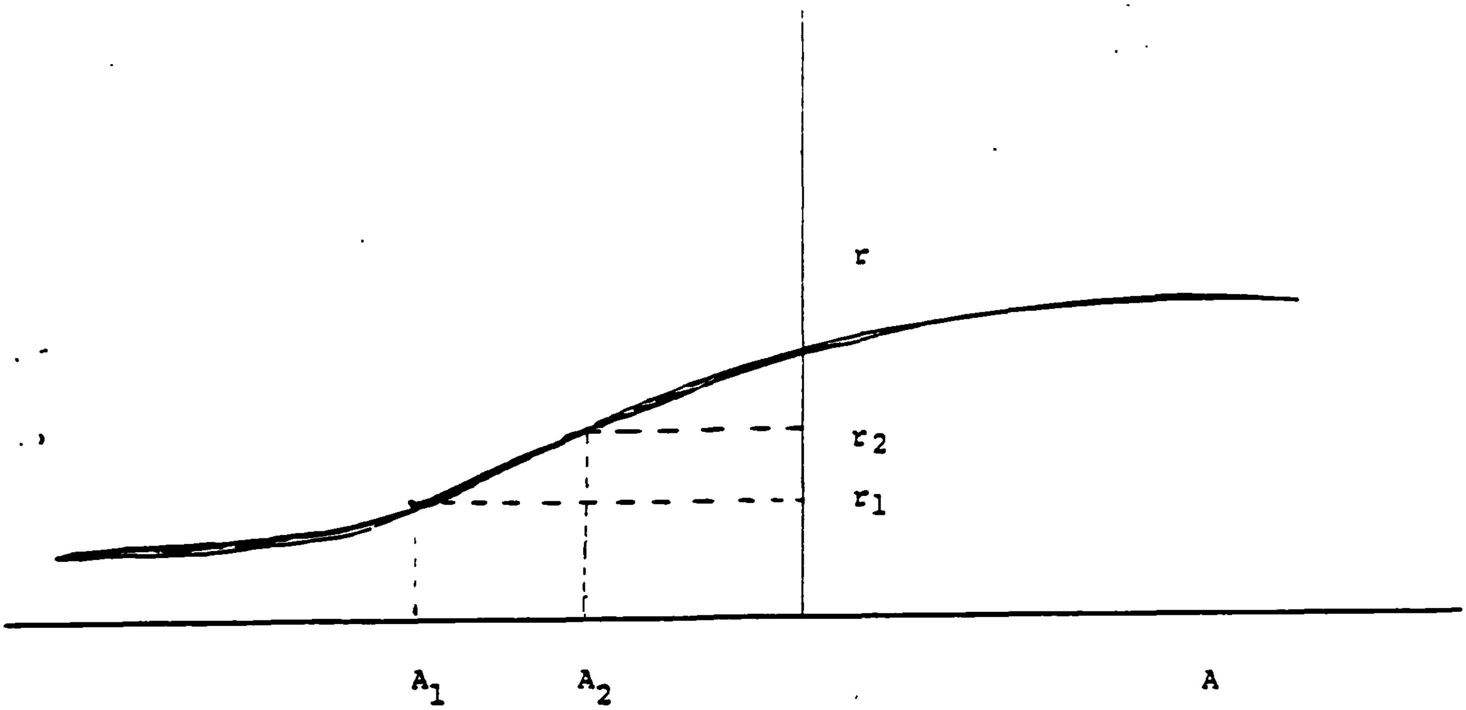

Figure 1: Reenlistment Supply Curve

and the reenlistment rate is plotted on the vertical axis.

To illustrate how this supply curve works, if A_1 is the annualized cost of leaving, r_1 is the associated reenlistment rate. If the annualized cost of leaving rises to A_2 due, say, to a bonus increase, the reenlistment rate will increase to r_2. An important point to note about this specification of the supply function is that r does not change at a constant rate as A changes (as it would if the supply curve was linear). A given change in A has a smaller impact on r when A (and hence r) is either very low or very high. This seems intuitively plausible. If A is very low, not many people are on the margin between staying or leaving -- most are leaving. A change in A won't induce many more people to stay. Likewise, if A is already very high (e.g. at the 16th or 17th year of service), most everyone is staying. Again, a pay increase, or a (small) pay decrease, won't induce m change in retention since most people are not at th margin of a stay-leave decision. In the middle of supply function, around the 50 percent reenlistment rate, pay changes have their largest impact on r.

In the empirical analysis, we assume that γ is distributed normally, and apply an estimation procedure called probit analysis to estimate the relationship between pay and retention. Note that if $f(\gamma)$ is normally distributed with mean μ_γ and standard deviation σ_γ, we can transform (2) to a standard normal probability function (normal distribution with mean 0 and standard deviation (1) as follows:

$$\Pr(-\gamma<A) = r = \int_{-\infty}^{\frac{A-\mu_\gamma}{\sigma_\gamma}} f(t)dt \qquad (3)$$

where $t = \dfrac{(-\gamma)-\mu_\gamma}{\sigma_\gamma}$ and $f(t) = \dfrac{e^{-\frac{1}{2}t^2}}{\sqrt{2\pi}}$.

This may be rewritten as,

$$\Pr(-\gamma < A) = r = \int_{-\infty}^{\beta_0 + \beta_1 A} f(t)dt \qquad (4)$$

where $\beta_0 = -\frac{\mu_\gamma}{\sigma_\gamma}$ and $\beta_1 = \frac{1}{\sigma_\gamma}$.

Probit analysis is an empirical procedure for estimating the parameters β_0 and β_1. For a discussion of the estimation procedure, see reference 3.

Once an estimate of β_1 is obtained we may compute the effect of a change in military pay (ΔM) on r. Let X be the standard normal variate associated with the reenlistment rate r. Also, since A=M-C, ΔA equals ΔM. Therefore, the new reenlistment rate r' is equal to $\int_{-\infty}^{X+\beta_1 \Delta M} f(t)dt$. While this equation is non-linear, the effect of a pay change on the reenlistment rate can easily be derived from tables for the standard normal distribution.

Note that other variables can be added to the model, and their effects estimated. If Z is a vector of other determinants of the reenlistment rate, then we may rewrite r as,

$$r = \int_{-\infty}^{\beta_0 + \beta_1 A + \beta_2' Z} f(t)dt \qquad (5)$$

Included in Z might be variables such as sea/shore rotation patterns, marital status, civilian unemployment rate, fiscal year dummies, etc.

In the analysis of second-term reenlistments, we will include the individual's first-term bonus multiple (FTBM) as a variable in the reenlistment equation. Again, the hypothesis is that those individuals who received a larger first-term bonus should be less likely to reenlist after their second-term than individuals who received a smaller first-term bonus.

To apply the probit model, we actually specified two different forms of the reenlistment equation. One specification is to compute M and C and then enter A=M-C as the pay variable in the equation. This method requires external estimates of each individual's civilian earnings profile if he leaves military service. From a study I did for the Third QRMC (reference 4), we know that post-service civilian earnings vary significantly by education, mental group, and race. Using the results of my previous study, we specified a civilian earnings function that varies by education level, mental group, race, and years of post-service experience. Civilian earnings were quadratic in post-service earnings.[1] Earnings differences from my previous study by education level and race are very similar to the differences by education and race found in Current Population Survey earnings data.

The earnings functions from my previous study are in 1969 dollars. The data for the current study are from the period FY 1974-78. We therefore updated the earnings functions by an index of weekly earnings growth to obtain post-service expected earnings profiles for each year FY 1974-78. This index grew about 32 percent over this period. This index is a conservative index of civilian wage growth over the period. In contrast to this civilian wage growth, Regular Military Compensation (RMC) grew about 28 percent from FY 1974 to FY 1978. Basic pay grew by only 22 percent. The much slower growth of basic pay is due to pay raise reallocations. Some of the pay raises during the period, especially the 1 October 1975 raise, placed a disproportionate share of the raises into allowances. From mid-FY 1974 to mid-FY 1978, the Consumer Price Index grew by about 28 percent. Real

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[1]Coefficients for the experience variables were determined from analysis of age-earnings profiles available in the Current Population Survey. These coefficients wre quite similar to those available from previous studies (reference 3).

military pay as measured by RMC did not decline during the sample period; real pay as measured by basic pay shows a marked drop, however.

The reader may note that civilian opportunities do not vary by military occupation group. My previous study did find earnings differences by military occupation. However, the lack of inclusion of pay differences by military occupation does not matter in the current analysis. This is because we are performing separate analyses for each rating or rating group (where we pool what appear to be homogenous ratings together). Since the analysis uses time-series data on individual ratings or homogenous rating groups rather than cross-section data on many dissimilar ratings, the lack of accounting for civilian earnings differences by military occupation won't affect the results.

For each individual in the data sample, we predict his (expected) future civilian earnings stream from leaving military service. Then, for each time horizon in which we are interested, we compute M, C, and A=M-C; A becomes the pay variable in the probit equation.

Note that by this specification, A will vary from one individual to another even if M doesn't. M won't vary from one individual to another, for instance, if we are analyzing a rating whose bonus multiples were not changed during the sample period. Since there will usually be a lot of variation in A irrespective of the variation in M, this specification almost always gives a positive, statistically significant estimate of β_1.

A disadvantage of this specification is that the estimates of β_1 will be biased if the earnings differences by education, mental group, and race are measured improperly. This may be the case, for example, if racial differences in post-service earnings depend upon the particular rating or occupation group being analyzed. Because of this potential bias problem, we specified a second form of the reenlistment equation. Suppose that C is equal to $a_0 + \sum_{i=1}^{k} a_i X_i$, where the X_i's are education, mental group, and race variables and the a_i's represent the effects of these variables on C. A may be written as $M - a_0 - \sum a_i X_i$. Then, we may write the reenlistment equation as follows.

$$r = \int_{-\infty}^{(\beta_0+\beta_1 a_0)+\beta_1 M-\beta_1 a_1 X_1 \ldots -\beta_1 a_k X_k+\beta_2' Z} f(t)dt \qquad (6)$$

This is a "reduced form" equation.

The advantage of this specification is that the estimate of β_1 will be unbiased. This is because we don't "predetermine" the effects of education, mental group, and race, but allow them to be estimated within the model. Like the first specification, this one has a disadvantage. For occupation groups there has been no substantial variation in M during the sample period, this method tends to give a low, statistically insignificant estimate of β_1.

The reader may have already inferred from the above discussion that there is a vexing problem in analyzing how military pay has changed during the sample period. The problem is whether the appropriate measure of military pay is RMC or basic pay. RMC almost kept up with civilian pay during the period; basic pay fell considerably behind. For those receiving all of their allowances in cash, RMC would seem to be the appropriate measure of pay. These individuals "see" the whole pay raise in their paychecks. However, individuals who receive their allowances in-kind do not receive the whole of the stated pay raise, only the fraction put in basic pay. If individuals actually value in-kind benefits at their cash value this might not be a problem. However, it is likely that they don't -- they perceive the pay raise to be only the portion put in basic pay.

The empirical problem is that we can't identify who received allowances in-kind and who received allowances in cash. We therefore have to choose either RMC or basic pay as the appripriate measure of military pay. The results presented below are based on the assumption that RMC is the appropriate measure of military pay. We are redoing some of the analysis assuming basic pay as the appropriate measure of pay to determine how sensitive the results are to this assumption. With this caveat in mind, we proceed to discuss the results to date.

EMPIRICAL ANALYSIS

This section presents the preliminary results of our empirical analysis. The first section describes the data and presents some summary statistics for the sample period. The second section shows our first-term results, while the third section presents our results for the second-term.

The Data

The data for this study were provided by the Defense Manpower Data Center (DMDC). DMDC maintains master and loss files which are extracts of the services' master records. From this data, DMDC assembled a longitudinal data file that tracks every enlisted person who had more than 23 months of service on 1 July 1973 either to the time of termination of service or to 30 September 1978. Individuals who move into YOS 3 in subsequent fiscal years are similarly tracked. Each person's record contains pre-service background data and military history data including dates of promotion and paygrade, rating, yearly assignment data, dates of reenlistment/extension, and ETS date.

From these data we identified and extracted all of the individuals who made first and second-term reenlistment decisions in the period FY 1974-78. Our sample contains approximately 220,000 first-termers and 50,000 second-termers. We have compared our base numbers and reenlistment numbers with official Navy numbers for each rating and fiscal year. For the most part, our data are consistent with the Navy's. They differ somewhat due to differences in definition of reenlistment eligibility and the fact that Navy numbers include extensions in the reenlistment numbers. Extensions of less than three years are not included in our reenlistment numbers, since they do not qualify for a bonus. Extensions are mainly a problem in analyzing data in ratings which have 6 YOs. Extenders are included in the data when they complete their extension and make a stay-leave decision.

After extracting the base cohort and the reenlistees in each fiscal year, we broke the Navy down into 16 occupational areas, which are shown in table 1. These groupings are an aggregation of the 24 area grouping found in the Navy NEC manual. Each area is an aggregation of ratings which are similar in terms of training and/or working environment. In the analysis presented below, we further subdivided some of the larger groups, and performed separate analyses on individual ratings or groups of highly related ratings.

The reader will note two things. First, all individuals with nuclear power NEC's have been eliminated from the analysis. We did this because of all the problems inherent in analyzing their retention behavior. Second, TDs are not to be found in table 1. This was an oversight that we will soon correct.

Table 2 shows the first-term sample sizes and the reenlistment rates in each group for the sample period. Table 3 shows the second-term sample sizes. The second-term reenlistment rates are much higher than the first-term rates. These second-term rates are for the whole period FY 1974-78 and mask a strong downward trend in second-term reenlistment rates in the Navy. Whereas the FY 1974 all-Navy second-term rate was

Table 1: Occupational Areas

1. Ship maintenance - HT, MR, ML, PM, IM, OM
2. Health care - DT, HM
3. Logistics - SK, AK, DK, MS, SH, CS, SD
4. Marine engineering - MM, BT, EM, IC, EN
5. Weapons systems/control - ET, FT
6. Aviation maintenance - AX, AT, AQ, AE, AD, AO, AM, AC
7. Construction - BU, CE, CM, EA, EO, SW, UT, CN, CR, BR
8. Administration - LN, NC, PN, PC, YN, AZ, AG
9. Ship operations - OS, QM
10. Communications/sensor systems - AW, RM, EW, ST, OT
11. Aviation ground support - AB, AS, PR
12. Data systems - DS, DP
13. General seamanship - BM, SM
14. Ordinance - GM, MN, MT, TM
15. Cryptology - CT, IS
16. Media - PH, DM, JO, LI, PT, MU

Table 2: First-Term Sample Sizes (FY 1974-78)

Occupational area	N	R	r
1. Ship maintenance	10,596	2,302	21.7
2. Health care	16,624	3,577	21.5
3. Logistics	19,637	6,022	30.7
4. Marine engineering	35,557	7,963	22.4
5. Weapon systems/control	12,781	2,911	22.8
6. Aviation maintenance	37,889	10,074	26.6
7. Construction	6,752	1,212	18.0
8. Administration	18,055	5,144	28.5
9. Ship operations	5,480	986	18.0
10. Communications/sensor systems	17,955	4,167	23.2
11. Aviation ground support	8,004	1,887	23.5
12. Data systems	3,170	711	22.4
13. General seamanship	9,790	2,541	25.9
14. Ordnance	7,858	2,349	29.9
15. Cryptology	6,264	1,394	22.2
16. Media	3,794	718	18.9

Table 3: Second-Term Sample Sizes (FY 1974-78)

Occupational area	N	R	r
1. Ship maintenance	1,811	1,110	61.3
2. Health care	2,984	1,873	62.8
3. Logistics	6,121	4,666	76.2
4. Marine engineering	5,730	3,343	58.2
5. Weapon systems/control	5,877	2,078	35.4
6. Aviation maintenance	8,652	5,001	57.8
7. Construction	1,759	1,193	67.8
8. Administration	3,830	2,485	64.9
9. Ship operations	667	394	59.1
10. Communications/sensor systems	3,969	2,091	52.7
11. Aviation ground support	1,041	688	66.1
12. Data systems	1,080	363	33.6
13. General seamanship	1,950	1,330	68.2
14. Ordnance	2,043	1,237	60.5
15. Cryptology	1,979	929	46.9
16. Media	707	420	59.4

almost 70 percent, the FY 1978 rate was less than 50 percent. By constrast, the first-term rates show no such trend over the period.

Analysis of First-Term Reenlistments

In our first-term analyses, we estimated single equations for the Medical Care, Logistics, Construction, Administration, Ship Operations, Data Systems, General Seamanship, Crypotology, and Media groups. Generally speaking, these are groups that either have small sample sizes or only two or three ratings within the group. We disaggregated the other groups and estimated reenlistment equations for single ratings or subgroups of ratings.

For each rating or occupation group for which reenlistment equations were estimated, table 4 shows the estimated coefficient on the two different forms of the pay variable included in the equation. A8D is the annualized cost of leaving deflated to 1974 dollars by the consumer price index. M8D is the similarly deflated, annualized value of military pay. The time horizon for the calculation of A8D or M8D in these equations is an assumed 4-year reenlistment. Thus, A8D represents the annualized cost of leaving at the end of the first-term rather than remaining for four more years. M8D repre-

Table 4: Estimates of β_1 in First-Term Reenlistment Equations

Occupation group/rating	A8D	M8D
HT	.000031(NS)	-.000058(NS)
OTHER SHIP MAINT.	.000196	.000176
HEALTH CARE	.000255	.000482
LOGISTICS	.000315	.000255
EM, IC	.000168	.000161
MM	.000005(NS)	-.000170
BT, EN	.000129	.000088
ET	.000226	.000144
FT	.000089	-.000195
AD, AM, AS	.000283	.000372
AC	.000120	.000016(NS)
AT, AX, AQ	.000193	.000185
AO	.000140	.000181
AB, PR	.000223	.000251
CONSTRUCTION	.000280	.000241
ADMINISTRATION	.000244	.000199
SHIP OPERATIONS	-.000015(NS)	-.000104
DATA SYSTEMS	.000232	.000178
GENERAL SEAMANSHIP	.000211	.000199
EW	.000151	-.000244
RM	.000178	.000143
OT	.000006(NS)	.000017(NS)
ST	.000030(NS)	-.000373
GM	.000118	.000161
MT	.000104	-
MN	.000228	.000300
CRYPTOLOGY	.000277	.000215
MEDIA	.000168	.000211

NS = Not statistically significant at .01 level.

sents the annualized value of military pay over the same horizon. This assumption is consistent with past stuides (reference 6 and 7).

In addition to A8D, the first form of the reenlistment equation also contained variables for marital status, and yearly dummies for the fiscal year in which the reenlistment decision was made. In addition to M8D, the second form included marital status, dummies for education level, mental ability, and race, and fiscal year dummies. In alternative equations, the civilian unemployment rate for males over the age of 20 was substituted for the fiscal year dummies. In most cases, this substitution of variables did not change the estimates of the pay coefficients very much.

Let us examine the results in table 4. The first message from the analysis is that the reenlistment rate is strongly positively related to the annualized cost of leaving or annualized military pay. Pay matters! In only a few ratings or occupation groups is an insignificant, or negative relationship between the included pay variable and the reenlistment rate estimated. Even in these groups we do not interpret the estimates to mean that individuals do not respond to pay changes, or respond negatively. The insignificant estimates may be due to data problems or other unobservable factors which have not been controlled for. There are some obvious discrepancies in the estimated pay coefficients in the two different forms of the supply equation. In general, however, the estimated pay coefficients are quite similar to one another. Where one specification yields a large estimated pay coefficient, the other does also. The second specification gives some negative estimates of the pay coefficients, which are obviously unreasonable. The reason for such results is unclear at the present time. Where the second model performs poorly (in the sense of giving very low or negative estimates of β_1), the results of the first model should be used to predict the effects of pay changes.

Results from both specifications suggests that there is considerable variation in the effects of pay on the reenlistment rate. For convenience, table 5 summarizes the results by classifying ratings or occupation groups into three pay response categories. This classification was made on the basis of the A8D coefficients.[1]

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[1]Since there are some disparities between the A8D and the M8D coefficients, one would obviously obtain a somewhat different classification if the M8D coefficients were used.

Table 5: Rating or Occupation Group Responses to Pay

Low:[a]	MM, HT, BT, EN, FT, OT, ST, EW, OS, QM, GM, MT
Medium:[b]	DS, DP, BM, SM, EM, IC, ET, EW, AT, AX, AC, AO, AQ, AB, PR, RM, Media, other ship maintenance
High:[c]	Health care, Logistics, Construction, Administration, Cryptology, AD, AM, AS, MN.

[a]Low: Estimate of β_1 less than .000120.
Medium: Estimate of β_1 between .000120 and .000180.
High: Estimate of β_1 exceeds .000180.

"Low" response groups are those for whom the estimate of β_1 is less than .000120. As we shall see below, this corresponds roughly to a pay elasticity of less than 2.0. "Medium" response groups are those for whom β_1 lies between .000120 and .000180. This category corresponds roughly to pay elasticities of between 2.0 and 3.0. The "High" category contains ratings whose estimates of β_1 exceed .000180. The implied pay elasticities for ratings in this category exceed 3.0.[1]

Generally speaking, the "high" category appears to be dominated by the more white-collar ratings. This seems reasonable. Given the generally better working conditions in these ratings, a smaller pay change is needed to effect the same reenlistment response as in the ratings with the more arduous working conditions. The two exceptions to these statements are the high estimates of β_1 for the Construction and Aviation Mechanics (AD, AM, AS) groups, which are blue collar jobs. These results may reflect basically equivalent

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[1]These statements shouldn't be taken too literally. The elasticity depends in part upon the base reenlistment rate. These implied pay elasticities are for a base rate of around .20.

working conditions in the Navy and in the civilian sector in these ratings.[1]

A general consistency in the results is that most of the electronics or electrical equipment repair ratings -- ET, EM, IC, AT, AX, and AQ -- fall in the medium pay response category. The lone exception is that FTs fall in the low response category. This may be a statistical fluke.

The rating groups that have the most arduous working conditions are the ones that are estimated to be least responsive to pay changes -- MMs, BTs, and HTs. Not only are these the ratings with the most arduous working conditions, they are also currently high bonus ratings. With some exceptions, most of the other ratings that fall into the low response category are also currently high bonus ratings.

Table 6 shows the estimated effects on the first-term reenlistment rate of a one level increase in the first-term bonus multiple in 10 ratings. The

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[1]The big pay effects in these two groups may also reflect a shock effect of bonus cuts. Both of these groups had very sizeable reductions in their bonuses in FY 1976, and much lower reenlistment rates thereafter.

Table 6: Estimates of First-Term Bonus Effects

Rating	Base r (FY 1978)	Δr due to one level increase in bonus multiple and implied pay elasticity A8D	M8D
HM	20.0	4.0 (2.77)	8.1 (5.50)
EM	26.6	3.9 (1.74)	3.2 (1.66)
ET	18.4	3.9 (2.40)	2.5 (2.00)
AT	39.5	4.0 (1.42)	3.9 (1.36)
YN	32.0	4.7 (2.03)	3.9 (1.65)
PR	36.2	4.2 (1.82)	5.1 (2.06)
GMG	25.4	2.0 (1.09)	2.7 (1.50)
CE	16.2	3.1 (2.60)	3.5 (2.96)
DP	19.3	3.0 (2.11)	1.7 (1.18)
CTT	28.0	4.5 (2.44)	2.8 (1.82)

methodology for calculating these bonus effects was discussed in the previous section. The table also shows the implied first-term reenlistment pay elasticity, $e_{r,p}$. $e_{r,p}$ equals $\%\Delta r/\%\Delta M$, where $\%\Delta r$ is the percentage change in the reenlistment rate and $\%\Delta M$ is the percentage change in the annualized value of second-term pay due to a one-level change in the bonus multiple.[1]

In table 6, the estimated effect of a one multiple increase ranges from 1.7 to 5.1 additional reenlistments per 100 eligible (ignoring the outlandish prediction for HMd from the M8D coefficient). Again, a one-level increase in the bonus multiple is estimated to have a larger effect in the white collar ratings -- CTT, HM, MS, YN. Using the A8D estimates, the median effect for these 10 ratings is 3.9. Using the M8D estimates, the median effect is 3.5. The average effect of a one-multiple increase in all Navy ratings would be less than 3.9 (or 3.5) since proportionately more first-term eligibles are in maintenance-related

[1]For comparable changes in the reenlistment rate, the pay elasticities reported here will be somewhat higher than those reported in earlier studies. This is because M is based on RMC rather than just base pay or base pay plus allowances.

ratings, which are estimated to have lower pay responses.

Overall, these results appear to be reasonably consistent with previous studies. Enns (reference 7) estimated that there would be 2 to 3 additional reenlistments per 100 eligibles due to a one level increase in the bonus multiple. The first-term pay elasticities implied by his results were around 2.0. His computations did not vary by rating or occupation group. If we computed an all-Navy effect of a one-- level multiple increase, it would be between 3 and 4 additional reenlistments per 100 eligible. While the "average" effect would thus be higher than that estimated by Enns, Enns himself felt that his results were on the conservative side. He reviewed a host of prior studies reporting pay elasticities larger than 2.0, and, consequently more than 2-3 additional reenlistees per 100 eligible.

An important point to remember is that our data come from the AVF era, whereas Enns' data come from the draft era and contained many draftees and draft-motivated enlistees. Since tastes for military service should vary much less among individuals in our data set than in Enns' (i.e. σ_γ is smaller), pay changes should elicit a larger retention response in the AVF era. On the whole, therefore, our first-term results appear to be quite consistent with those from past studies. Whether the results for each rating taken individually are reasonable is another matter. These results for individual ratings should be regarded as preliminary. No doubt they will undergo much scrutiny by us and others before they can be used for planning purposes or policy analysis.

Analysis of Second-Term Reenlistments

In the analysis of second-term reenlistments, we computed the pay variables A and M for two different time horizons. The first horizon was again an assumed four year length of reenlistment and the second was a time horizon from the individual's current YOS to YOS 20. Below, the pay variables for the 4-year time horizon are denoted A12D and M12D respectively, while the pay variables for the time horizon encompassing YOS 20 are denoted A20D and M20D, respectively. Again, the "D" indicates that all values were deflated to 1974 dollars using the Consumer Price Index. The reason for constructing a pay variable based on a time horizon encompassing YOS 20 should be clear.

Table 7 displays the results. Let us first examine the results based on the 4-year time horizon. They are quite mixed. In some of the ratings/occupation groups the estimated coefficients are low and statistically insignificant, frequently negative. How can this be? The answer is that most of the negative estimates are obtained in the ratings/occupation groups where bonuses increased substantially over the sample period. Where such bonus increases occurred, the A12D or M12D actually increase over the sample period. Therefore, since the pay variable is <u>higher</u> at the end of the sample period, while retention is <u>lower</u>, a negative relationship is estimated.[1]

In the ratings/occupation groups where second-term bonuses were not paid at any time during the sample period, A12D declines over the period due to the more rapid growth of civilian than military pay. In these groups, the declining cost of leaving is positively related to the declining reenlistment rate, as expected. Since RMC is the assumed measure of military pay, M12D shows no trend over the sample period in the

[1]If the pay variable were constructed using basic pay rather than RMC, it is possible that A12D or M12D would decline between FY 1974 and FY 1978 in the large bonus ratings.

Table 7: Estimates of β_1 In Second-Term Reenlistment Equations

Occupation group/rating	A12D	M12D	A20D	M20D
HT	-.000118	-.000261	.000098	-.000168
OTHER SHIP MAINT.[a]	-.000058[b]	-.000190	.000191	-.000113
HEALTH CARE	.000275	.000336	.000309	.000368
LOGISTICS	.000199	.000342	.000252	.000318
EM, IC	.000087	-.000016[b]	.000303	.000012[b]
MM	.000007[b]	-.000039	.000193	-.000019[b]
BT, EN	-.000097	-.000172	.000090	-.000143
ET	.000114	.000056	.000268	.000085
FT	-.000054[b]	-.000111	.000099	-.000014[b]
AD, AM, AS	.000217	.000251	.000225	.000262
AC[a]	-.000216	-.000311	.000064[b]	-.000140[b]
AT, AX, AQ	.000005[b]	.000005[b]	.000159	.000092
AO	-.000034[b]	.000019[b]	.000096	.000148
AB, PR	.000237	.000117	.000318	.000195
CONSTRUCTION	.000101	.000117	.000144	.000118
ADMINISTRATION	.000200	.000050	.000231	.000131
SHIP OPERATIONS[c]	.000017[b]	-	.000117[b]	-
DATA SYSTEMS	-.000041[b]	-.000239	.000192	-.000116[b]
GENERAL SEAMANSHIP	.000069[b]	-.000011[b]	.000014[b]	.000014[b]
EW[a]	.000007[b]	-.000111[b]	.000307	.000116
RM	-.000126	-.000153	.000094	-.000017[b]
OT[a]	-.000253	-.000543	.000009[b]	-.000355[b]
ST	-.000095	-.000233	.000139	-.000099
GM	-.000019[b]	-.000232	.000158	-.000145
MT[a]	.000482	.000495	.000503	.000562
MN[a]	.000189[b]	.000144[b]	.000403[b]	.000319[b]
CRYPTOLOGY	.000192	.000178	.000386	.000219
MEDIA[c]	.000056	-.000078	0	.000046[b]

[a]Sample size less than 500.

[b]Not statistically significant at .01 level.

[c]Sample size less than 1,000.

no bonus groups. This is because nominal RMC and the CPI increased about 28 percent. However, a positive relationship is usually estimated between M12D and the reenlistment rate in the no bonus groups. This is because (1) the included fiscal year dummies control for the more rapid increases in civilian wages, and (2) during any given fiscal year individuals with larger values of M12D (e.g. those in higher pay grades) have a higher propensity to reenlist. In the no bonus occupation groups, the estimates of β_1 from the alternative specifications are in most cases reasonably similar.

Let us look at the parameter estimates when the pay variables are based on a time horizon to YOS 20, examining first the results when A20D is the included pay variable. In this case <u>all</u> of the estimates are positive, and most are statistically significant at the .01 level. Insignificant estimates are obtained primarily in groups with small sample sizes.

Why do we tend to get "better" results with A20D than we did with A12D? The answer is that even in the ratings where bonuses increased substantially during the sample period, A20D declines from FY 1974 to FY 1978 becase the increases in civilian pay have reduced

A20D more than the bonus increases have raised it. Falling values of A20D over the sample period "track" the decline in retention, even in the ratings where bonuses have increased substantially. M20D doesn't "work" as well as A20D, for reasons which, at the moment, aren't entirely clear.

How should the above results be used to calculate the effects of pay (bonus) changes. The answer hinges on the question of the appropriate time horizon -- i.e. is it 4 years or a horizon that encompases YOS 20. The discussion in the first section was sketchy; reference 2 discusses this issue in more detail. It shows that the appropriate time horizon is the one that maximizes the annualized cost of leaving. That is, if the annualized cost of leaving is low over one horizon (e.g. a four year horizon) but high over another horizon (e.g. the horizon encompassing YOS 20), it is the annualized cost of leaving over the latter horizon that is relevant to the individuals retention decision. Thus, we may decide upon the appropriate time horizon by comparing values of A over alternative horizons. Once the appropriate time horizon has been decided upon, we determine how a bonus change affects A over that horizon, and then calculate the new reenlistment rate

$r' = \int_{-\infty}^{X_0+\beta_1\Delta A} f(t)dt$ where ΔA is the change in A and X_0 is the standard normal variate associated with the base reenlistment rate.

As it turns out, A20D almost always exceeds A12D (assuming a 10 percent personal discount rate).[1] Only in a limited number of high bonus ratings does A12D exceed A20D. Equations estimated with A20D as the pay variable are essentially equations estimated using the maximum value of various possible A values.[2]

Based on this logic, we have used the A20D coefficients to estimate the effects of second-term bonuses in various Navy ratings. We calculate how a one level bonus multiple change changes A20D and then determine the change in r using the methodology described above.

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[1]If the discount rate were higher, A12D would exceed A20D more often. A 10 percent discount rate is consistent with our knowledge about the discount rates of individuals at the second-term reenlistment point (reference 1).

[2]One will note in table 7 that for many groups (e.g. Health Care) the estimate of β_1 is similar whether A is based on a 4-year horizon or a horizon to YOS 20. Even though A12D is lower than A20D, they are very highly correlated, and hence we obtain the same estimation results regardless of which variable is used.

Table 8 shows the estimated effect on second-term reenlistment rates in 10 ratings of a one level change in the second-term bonus multiple. Also shown is the estimated pay elasticity.[1] The 10 ratings in table 8 are the same 10 for which first-term bonus responses are predicted in table 6. There is a general consistency in the first- and second-term results in that the ratings that are predicted to have larger pay responses at the first-term reenlistment point are predicted to have larger responses at the second. With several exceptions (e.g. YNS and CEs) the predicted changes to the second-term reenlistment rates are similar to the predicted changes in the first-term rates. However, the percentage increases due to a one level multiple increase are smaller than for the first-term.

Frankly, we expected somewhat larger second-term pay responses. There are various theoretical reasons for expecting that the second-term pay responses would have

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[1]One must be careful in comparing these elasticities with the ones in table 6. Elasticities based on a longer time horizon will be larger than those based on a shorter time horizon, even if the predicted change in reenlistments is the same in both cases.

Table 8: Estimates of Second-Term Bonus Effects in 10 Ratings

Rating	Base R (FY 1978)	FY 1978 bonus multiple	Predicted ΔR due to one level increase in bonus multiple	Pay elasticity
HM	53.4	0	3.9	2.23
EM	41.4	0	4.0	3.32
ET	33.8	0	3.4	3.55
AT	38.2	0	2.0	1.87
YN	51.3	0	3.0	1.72
PR	51.7	1	4.9	2.33
GMG	53.2	0	2.0	1.27
CE	28.2	0	1.5	1.66
DP	44.9	0	2.4	1.65
CTT	48.9	1	5.0	3.50

been larger than the first term responses.[1] Despite this, the bonus improvement factors implied by the estimates in table 8 are pretty close to those now being used by the Navy and OSD. For a base reenlistment rate of .35-.50, the current table predicts a 10 percent increase (.035-.05) in ratings which currently receive no bonus down to a 6 percent increase (.021-.03) for ratings receiving a level 5 bonus.

The Effects of First-Term Bonuses on Second-Term Reenlistments

We turn now to estimation of the effects of first-term bonuses on second-term reenlistments. To repeat, the hypothesis is that those individuals who received large first-term bonuses will have a lower seond-term reenlistment probability than those who received a lower first-term bonus. To test the hypothesis, the first-term bonus multiple the individual received (FTBM) was included as a variable in the second-term

[1]The primary reason for expecting a larger pay response at the second-term is that the taste distribution should be less diffuse among second-term reenlistees (i.e. σ_γ smaller). Since those with larger negative tastes were eliminated at the first-term reenlistment point, Applying the notion of "transitory" disturbances discussed in reference 2, however, the sum of the variances of the permanent taste factors and transitory disturbance ϵ may be greater at the second-term, hence making the second-termers less responsive to pay changes. This is to argue that σ_γ is not independent of the term of service. At this point, this interpretation of the results is speculative.

equation.

Table 9 shows the coefficient estimates for the FTBM variable. These are the estimates from reenlistment equations that include A20D, marital status, and fiscal year dummies. The estimates were fairly stable with respect to model specification. Most of the estimates are negative, providing support for the hypothesized relationship. The statistical significance of the estimates varies considerably. However, the estimates are usually statistically significant in ratings or occupation groups where sample sizes are large and/or there is a lot of variation in FTBM. The largest estimates of the FTBM coefficient are obtained in precisely those groups where there was a lot of variation in FTBM (e.g. HTs, ACs, GMs).

There is a reason for the positive estimates for the ETs, BT-EN group, the ship operations group. These groups all have reductions in FTBM about half-way through the period FY 1978-74. Therefore, the individuals coming up for reenlistment in FY 1977-78 had lower FTBMs than those reenlisting earlier. Since those coming up for reenlistment in FY 1977-78 generally had lower reenlistment rates, we estimate a positive relationship between FTBM and the reenlistment

Table 9: Estimates of Effect of FTBM In Second-Term Equations

Rating/ occupation group	Coefficient (t value)
HT	-.09 (3.8)
OTHER SHIP MAINT.[a]	.03 (.6)
HEALTH CARE	-.09 (2.7)
LOGISTICS	.03 (.6)
EM,IC	-.06 (2.0)
MM	-
BT,EN	.06 (3.3)
ET	.10 (8.7)
FT	-.04 (1.4)
AD,AM,AS	.05
AC[a]	-.09 (2.0)
AT,AX,AQ	-.06 (3.7)
AO	.05 (1.1)
AB,PR	-.07 (1.1)
CONSTRUCTION	-.02 (.4)
ADMINISTRATION	-.13 (3.0)
SHIP OPERATIONS[b]	.06 (1.6)
DATA SYSTEMS	-.08 (1.6)
EW	-.05 (1.0)
RM	-.03 (1.5)
OT[a]	-.07 (1.0)
ST	-.04 (1.9)
GM	-.05 (1.9)
MT[a]	-.03 (.9)
TM	-
MN[a]	-.12 (.7)
CRYPTOLOGY	-.03 (1.6)
MEDIA[b]	-.11 (2.8)

[a]Less than 500 observations.

[b]Less than 1,000 observations.

- : no variation in FTBM.

rate. In these groups, the effects of FTBM are confounded with other factors causing a downward trend in second-term reenlistments. In groups where a negative relationship is estimated, FTBM was usually raised somewhere in the period FY 1968-74, and this increase explains some of the drop in second-term reenlistment rates in the latter part of the FY 1974-78 period.

From the estimates in table 9, we may derive the future change in the second-term reenlistment rate (r_2) due to a one level change in FTBM. Since the estimates are based on a normal distribution, the maximum effect occurs at a base reenlistment rate of .50. For this base rate, the largest coefficient, -.12 for MNs, implies a change in r_2 of -.048. That is, the future r_2 would drop to .452. A coefficient of -.05 would imply a drop in r_2 of -.02. A coefficient of -.03 would imply a drop of -.012. At a base r_2 of .50, these various coefficients imply between a 2.4 percent and a 9.6 percent drop in r_2.

From these estimates, we may derive some rough estimates of the fraction of bonus-induced first-term reenlistments who leave at the end of their second enlistment. Define the elasticity of the second-term rate with respect to the first-term rate, e_{r_2,r_1}, as $\%\Delta r_2$ $\%\Delta r_1$. I have shown theoretically (reference 2) that e_{r_2,r_1} lies between 0 and -1 in value. A value of 0 obviously means that there is no relationship; a value of -1 means that all of the extra first-term reenlistments obtained by a higher first-term bonus leave after their second-term. Both 0 and -1 are extreme values; we expect something in between (see the discussion in reference 2).

Since $\%\Delta r_1 = e_{r_1,M_1} \%\Delta M_1$ -- where e_{r_1,M_1} is the first-term bonus elasticity and ΔM_1 is the percentage change in second-term pay due to a first-term bonus -- we may rewrite e_{r_2,r_1} as $\%\Delta r_2 \div e_{r_1,M_1} \cdot \%\Delta M_1$. To compute e_{r_2,r_1} we need to know $\%\Delta r_2$, e_{r_1,M_1} and $\%\Delta M_1$.

To make our rough estimates, we will choose the 10 ratings in tables 6 and 8. To make the calculations apply to the sample period, we assume that the base second-term reenlistment rate is the FY 1974 rate. In other words, this approximates the second-term reenlistment rate of non-bonus induced individuals. then, we took the FTBM coefficient in table 9 applicable to each of these ratings and calculated Δr_2 and $\%\Delta r_2$. Finally, we took as the estimate of e_{r_1,M_1} for each rating the elasticity reported in the first column of table 6. This obviously introduces some error into the calculations since these estimates are not drawn from the same cohort for whom we are predicting FTBM effects. Anyway, these calculations should be regarded as merely illustrative at this point. The denominator of e_{r_2,r_2} is $e_{r_1,M_1} \cdot \%\Delta M_1$. We assume $\%\Delta M_1$ to be .05.

The calculations are shown in table 10. The largest estimate is -.86; the smallest is -.08. The range of other estimates is -.22 to -.57. That is, we can expect somewhere between one-fifth and three-fifths of the extra first-term reenlistees obtained by a higher first-term bonus to leave at the end of their second-term.

At this point, the calculations in table 10 should be viewed as merely illustrative. The important point is that we have uncovered evidence that there is a significant negative relationship between compensation and hence retention at one reenlistment decision point and retention at future decisions points. This relationship has implications for a variety of compensation issues including retirement reform (see reference 1).

Table 10: Estimates of e_{r_2,r_1}

Rating		e_{r_2,r_1}
HM		-.38
EM	-.80	-.50
ET		NC[a]
AT		-.51
YN		-.86
PR		-.42
GMG		-.57
CE		-.08
DP		-.49
CTT		-.22

[a]NC = not calculated since estimated FTBM coefficient was positive.

AGENDA

In the immediate future, our first task is to see how the results will change when the models use basic pay as the measure of military pay rather than RMC. Concurrently, we will be discussing the results with Navy and OSD bonus program managers. Once a "reasonable" set of pay responses has been agreed upon, the practical output of this study will be a set of bonus improvement factor tables comparable to the current tables. We expect that some collapsing of the ratings/occupation groups will be feasible. As a matter of fact, it will probably be feasible to classify the ratings/occupation groups into "low", "medium", and "high" response categories and produce three improvement factor tables comparable to the currently used tables.

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